# Job Description

## Research Associate

Salary: Grade 07

Contract: fixed term

School/Department: (School of Computing)

Location: Canterbury/Medway Campus

Responsible to: David Castro-Perez

### Job purpose

The purpose of this position is to help in the mechanisation of algorithms for deciding bisimilarities in a proof assistant. Such algorithms will be used as part of a growing framework for the verification of concurrent and distributed systems. This position is part of the EPSRC project “MEBI: Mechanised Bisimilarities and Behavioural-typed Processes”.

Behavioural-typed process calculi are formalisms that have been successfully used to guarantee the absence of deadlocks, livelocks, and race conditions in message-passing concurrent and distributed systems. However, the correctness of such techniques rely on complex pen-and-paper proofs that are hard to check or extend. This has caused several instances of unsound extensions to known theories, or bugs in the implementation of such theories. A potential solution to such problems is the mechanisation of these techniques as part of a proof assistant. Unfortunately, such mechanisations are hard, and there are many hurdles that need to be overcome, e.g. binder representation, mechanising process semantics, or reasoning about process equivalences. The MEBI project focuses on simplifying the mechanisation of process equivalences by encoding well-known algorithms for deciding bisimilarities in the Coq proof assistant, and using them to mechanise two proof-of-concept behavioural-typed process calculi.

The successful candidate will work in close collaboration with the PI, an expert in mechanisation of session-type systems (David Castro-Perez), as well as two project partners: (1) Dr Alceste Scalas, an expert in session-type theory and implementation, and (2) Prof. Marco Carbone, an expert in concurrency theory.

### Key accountabilities

* Studying and selecting bisimilarity algorithms that are suitable for integrating with a proof assistant.
* Extending the Coq proof assistant with tactics based on algorithms for deciding bisimilarities.
* Assistance in the development of the project’s case studies, focusing in the extraction of verified code.
* Assistance in the evaluation of the project outcomes, by comparing the case studies with state-of-the-art mechanisations.
* Working as part of a team.
* Communication and dissemination of the project outcomes.

### Key duties

The following are the main duties for the job. Other duties, commensurate with the grading of the job, may also be assigned from time to time.

* Implementation of algorithms for deciding bisimilarities in the Coq theorem prover (either in Gallina, or in OCaml as part of a Coq plugin).
* Implementation in Coq of proof-of-concept behavioural typed calculi.
* Interfacing Coq implementations of process calculi with the algorithms for deciding bisimilarity.
* Gathering and modelling case studies.
* To assist evaluation of results in a principled way, e.g., via comparison with state-of-the-art mechanisations of process calculi.
* Day-to-day liaison with the PI and other project partners.
* To periodically report on progress in oral and written form.
* To write research papers and reports on the outcomes of the work.
* To present the research outcomes at conferences and workshops.
* To communicate as widely as possible the results of the project by means of video and social media, as well as by more traditional means.

### Internal & external relationships

**Internal:** David Castro-Perez

**External:** Project partners: Marco Carbone (IT University of Copenhagen), Alceste Scalas (DTU Compute)

### Health, safety & wellbeing considerations

This job involves undertaking duties which include the following health, safety and wellbeing considerations:

* Regular use of Screen Display Equipment

### Person specification

The person specification details the necessary skills, qualifications, experience or other attributes needed to carry out the job. Applications will be measured against the criteria published below.

Selection panels will be looking for clear evidence and examples in an application, or cover letter (where applicable), which back-up any assertions made in relation to each criterion.

**Essential Criteria:**

* PhD (or nearing completion of study for one) or equivalent, in Computer Science, especially with research interests in programming languages (A)
* Strong knowledge and hands-on experience of functional and concurrent programming (A,I,T)
* Good grasp of type systems and typed programming language definitions (A,I,T)
* Research experience in either programming language theory or practice (A,I,T)
* Experience of presenting to academic audiences (A)
* Excellent problem solving skills (I)
* Excellent mathematical skills (I)
* Excellent programming skills (I)
* Excellent skills in planning and prioritisation, and ability to meet deadlines (I)
* Ability to act on own initiative within the framework of the aims and methods of the project (I)
* Firm commitment to achieving the University’s vision and values, with a passion for a transformative student experience and multidisciplinary, impactful research (I)
* Commitment to deliver and promote equality, diversity and inclusivity in the day to day work of the role (I)

**Desirable Criteria:**

* Experience with the OCaml programming language (A, I)
* Experience with proof assistants (ideally Coq) (A, I)
* Knowledge of concurrency theory, pi-calculus, bisimilarity (A, I)
* Research experience in proof theory, type systems, and semantics (A, I)

 *Assessment stage: A - Application; I - Interview; T - Test/presentation at interview stage*